United States Department of Agriculture
Forest Service

Francis Marion National Forest

Draft Forest Plan Assessment

Francis Marion National Forest, Berkeley and Charleston Counties, South Carolina

Section 3.6, 3.7 and 3.8 Natural Vegetation Succession, Natural Disturbance and Human Disturbance

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Francis Marion National Forest
Draft Forest Plan Assessment
Berkeley and Charleston Counties, South Carolina

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3.6.1.1 Preliminary Findings

1. Stresses to natural succession on the Francis Marion National Forest include lack of frequent prescribed fire, an over-abundance of loblolly pine due to past land management practices, and past wetland modifications.

3.6.1.2 Changing Conditions

Natural succession refers to changes in the development of vegetation in an area over time, particularly following natural disturbances such as wildfire, wind and hurricanes, insect and disease outbreaks, or droughts. The FEIS, "Vegetation" section of the 1996 revised Forest plan notes that in the absence of ecological community classification and a potential natural vegetation classification system, dominant forest cover types and age-class distributions for each type represent successional stages reflecting different plant communities (page III-24). To integrate new information regarding natural ecosystems and associated vegetation dynamics, this discussion on natural succession is consistent with vegetation dynamics from biophysical settings models in LANDFIRE (www.landfire.gov) as they relate to our ecological systems framework, as well as information on land use history. Stresses to natural succession on the Francis Marion National Forest include lack of frequent prescribed fire, an over-abundance of loblolly pine due to past land management practices, and past wetland modifications.

3.6.1.3 Past and Likely Future Trends

People have harvested timber from southern forests for more than 300 years since European settlement, and most forests have been harvested multiple times (Wear and Greis 2012). By 1900 it was evident that longleaf pine replaced itself only sporadically in a tiny percentage of its former landscape, and by 1967, loblolly pine plantations had been established on 12,460,000 acres throughout the Southeast (Frost 1993). The near elimination of once-dominant longleaf pine ecosystems was perhaps the greatest ecosystem alteration resulting from intensive forest management and land use conversion in the South (Wear and Greis 2012). Loblolly pine is currently the most abundant tree species on the Francis Marion occupying over 87,317 acres. Much of our loblolly pine was planted and then increased significantly following Hurricane Hugo (USDA Forest Service 1985). Although a component of bottomland forests originally, loblolly pine is a versatile tree species and a prolific seeder, and will continue to aggressively alter natural succession on all ecological system types in the future.

The acreage in loblolly pine forest types on the Forest has declined from 114,917 acres in 1985 (FEIS 1985). This decline represents a shift to changes from pure loblolly pine to mixtures with hardwoods, though the majority of our loblolly pine forests occur on wet pine savanna and longleaf pine woodland sites (Simon and Hayden 2013; Longleaf Assessment 2010). Loblolly pine regeneration has also affected the composition of dry to mesic oak hickory forests, mesic hardwoods, bottomland and stream floodplain forests, nonriverine swamp hardwood forests, and maritime forests. Trends in forest cover are consistent with declines in the acreage prescribed burned on the Forest over time and acreage in potential longleaf ecological systems prescribed burned (see section 3.4 "Wildland Fire and Fuels"). In the absence of prescribed fire, many of our loblolly pine stands have hardwood tree subcanopy/midstory and hardwood shrubs/sprouts, though distinguishing between fire-suppressed longleaf and original presettlement hardwood or hardwood pine can be problematic once the characteristic longleaf groundcover has become lost (Glitzenstein and Streng 2011). Loblolly pine forests on mesic and wetter sites will often have an abundance of early successional woody species, such as red maple and sweetgum, and little understory development. Many of our loblolly pine stands have been managed with high basal areas and on wet pine savanna sites, loblolly pine regeneration will interfere with understory development.

When prescribed burned frequently and thinned, loblolly pine forests can behave similarly to longleaf pine woodlands and savannas, and support a diversity of wildlife and plant species.

Longleaf pine ecosystems are "fire-climax" ecosystems; that is, the climax or old-growth vegetation is dependent on frequent prescribed fire. In the complete absence of fire longleaf pine forests succeed to Southern mixed hardwood forests (Ware et al. 1993) or mixed hardwoods with loblolly pine (2013 FS VEG data and trends; Glitzenstein and Streng 2011).

With frequent prescribed fire including a growing-season component, there tends to be an abundant and diverse ground cover of grasses and herbaceous plants (Natureserve 2012; Glitzenstein and Streng 2003). Long-term fire suppression depresses species diversity in these systems, resulting in a substantial hardwood understory and mid-story dominance (Brockway 2002). Mesic, wet-mesic, and more fertile sites succeed the most rapidly to woody shrubs, loblolly pine, and hardwoods in the absence of fire, and comprise the most fire-dependent vegetation, whereas dry and xeric sites may persist with more minimal management (Glitzenstein and Streng 2003; Brockway 2002; Frost 1993).

Acres of inland swamps were cleared for fields and when the inland rice system was abandoned towards the end of the Revolutionary War the fields reverted to swamp forests. Porcher and Rayner (2001) provide an extensive account of effects of the rice culture on the natural history of the Lowcountry, including the inland swamp system period and the tidal system period. In coastal wetlands, the swamp forests that developed on abandoned rice fields have become climax communities (Porcher and Rayner 2001). Abandoned rice fields follow a "hydrach" succession (succession that begins in water), shifting from floating species, to emergent species, and ultimately raising the soil level by trapping sediment, decomposition, and a reduction of soil moisture through transpiration. Once the soil is raised above the water table, the wind-borne fruits of bald cypress, red maple, willow, loblolly pine, cottonwood, sweet gum, and swamp gum can be established. On the Francis Marion, we have much evidence of draining and diking, though many areas have succeeded to forested swamps and maritime forests. Within the salt marsh, maritime forest comprised of palmetto, live oak, and coastal red cedar have established themselves along old dikes created when the marshes were once drained. In the absence of intensive or frequent disturbance, nonriverine swamps will continue to be abundant on the Forest (SE-GAP 2013), though oaks may establish less readily in these forests following intensive disturbance.

3.7 Natural Disturbance

3.7.1 Preliminary Findings

1. There is no direction in the 1996 Forest plan that responds to natural disturbances.

2. The time period 2000–2009 was noted as an exceptionally dry period on the Francis Marion National Forest. The average annual precipitation according to PRISM (Gibson et al. 2002) for 2000–2009 was 47.4 inches, while the longer-term average from 1980–2009 discussed previously in this section was 50.6 inches.

3. In the Southeast region, the area of moderate to severe spring and summer drought has increased by 12 percent and 14 percent, respectively, since the mid-1970s. Even in the fall months when

precipitation tended to increase in most of the region, the extent of drought increased by 9 percent (Karl et al. 2009).

4. Analysis of the NASH (North Atlantic Subtropical High) system since the 1940s, as well as analysis of future projections, suggest the system will likely intensify, expand, and more farther westward in the 21st century with the increase of carbon dioxide. This shift indicates the increased likelihoods of both extreme rainfall events and drought over the southeastern United States in the future (Li et al. 2010).

5. The average intensity of tropical cyclones is expected to increase by 2 to 11 percent while the frequency of tropical cyclones occurrence is expected to decrease by 6 to 34 percent. The most intense storms produce by far the greatest damage (Biasutti et al. 2011). A recent study using an operational hurricane prediction model shows a tendency towards increased frequency of Atlantic category 4 and 5 hurricanes over the 21st century (Knuston et al. 2010).

6. Storm-surge incidence from tropical cyclones would be expected to increase (Knuston et al. 2010).

7. In a study of the Hobcaw Forest in coastal South Carolina after Hurricane Hugo, Gresham reported that longleaf pine (*Pinus palustris*) suffered less damage than loblolly pine (*Pinus taeda*) (Johnsen et al. 2009).

8. The number of freezing days in the Southeast has declined by 4 to 7 days per year for most of the region since the mid-1970s (Karl et al. 2009).

9. For the SRES [Special Report on Emissions Scenarios] A2 and A1B emission scenarios, a 1-in-20-year hottest day is likely to become a 1-in-2-year annual extreme by the end of the 21st century (Senevirante et al. 2012).

10. Recent studies have shown that sea level may rise by 0.8 to 2.0 meters (31 to 78 inches) by 2100 (Pfeffer et al. 2008). Even with no increase in hurricane intensity, coastal inundation and shoreline retreat would increase as sea-level rise accelerates, which is one of the most certain and most costly consequences of a warming climate (Karl et al. 2009).

11. Adjacent to the Forest, Cape Romain's barrier islands will suffer from the effects of coastal erosion in addition to inundation as sea levels rise. The low sea-level-rise scenario predicts a 31 centimeter rise in sea level and 22 centimeters of subsidence by the year 2100. As a result, sea-level rise may inundate 51.4 percent of Cape Romain. Thus, the barrier islands may become fragmented as a result of subsidence and sea-level rise. The destruction of these barrier islands will allow increased wave energies onto the refuge's marsh (Daniels et al. 1993).

12. In reviewing the results from the Sea Level Rise Affecting Marshes Model (SLAMM) predicted landcover change between 2000 and 2050 is dominated by conversion of upland undeveloped to scrub/shrub transitional marsh. The latter half of the century (2050 to 2100) is characterized by more gradual conversion of scrub/shrub transitional marsh to other conditions, including salt marsh.

13. For information regarding gap phase regeneration and tree fall gaps refer to the LANDFIRE disturbance descriptions in section 2.1.1.6 "Past and Likely Future Trends".

14. For information regarding historic burning and lightning fires refer to Section 3.4 of this report.

3.7.1.1 Existing Information

The best available science information provided in this section is based primarily on models and literature derived through the use of the Template for Assessing Climate Change Impacts and Management Options (TACCIMO) http://www.taccimo.sgcp.ncsu.edu/

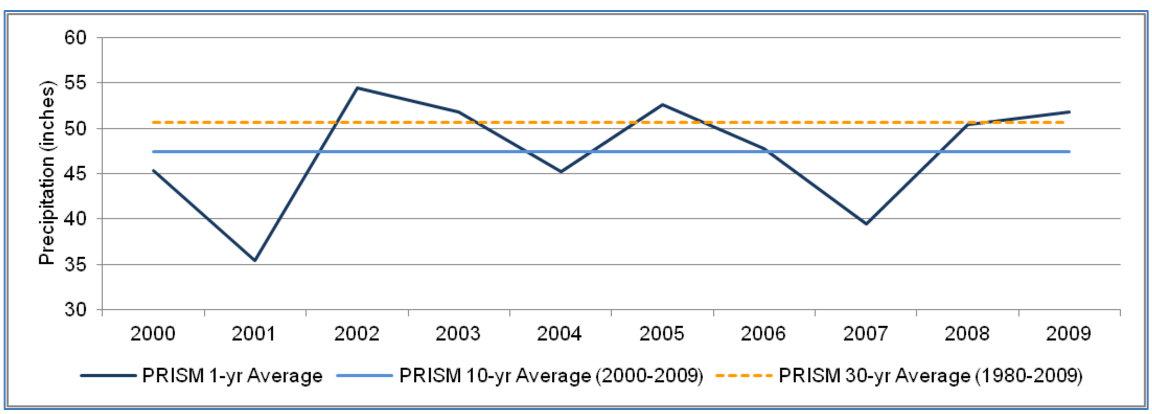
3.7.1.2 Current Condition and Trends

Broad scale disturbance regimes including flooding, drought, tornadoes, downbursts, ice storms, hurricanes, temperature extremes and sea-level rise have impacted the Francis Marion National Forest in the past and are anticipated in the future.

Flooding and Drought

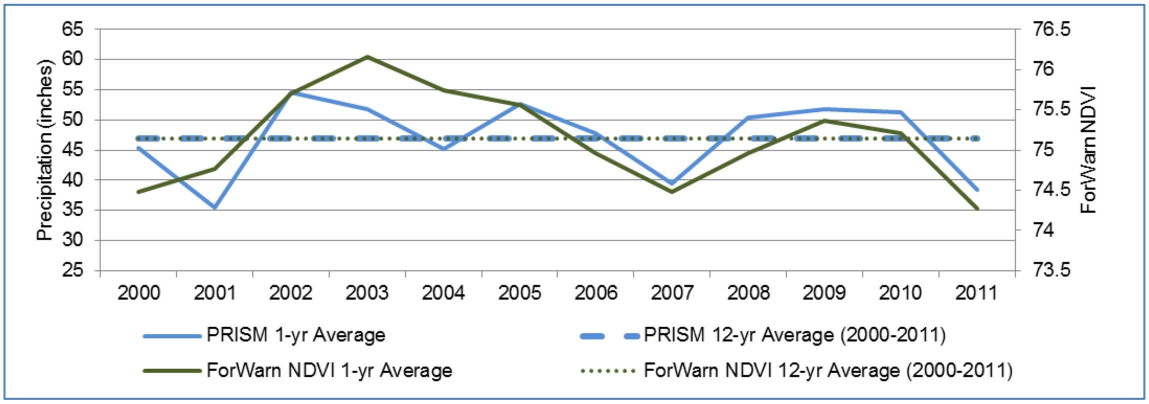
The time period 2000 to 2009 was noted as an exceptionally dry period on the Francis Marion. The average annual precipitation according to PRISM (Gibson et al. 2002) for 2000 to 2009 was 47.4 inches, while the longer-term average from 1980 to 2009 discussed previously in this section was 50.6 inches. This 9.4 percent decrease in precipitation, apparent when comparing the notably dry period to the longer-term average, illustrates the potential practical implications that shifts in long-term climate can have. In addition, the inter-annual variability responsible for the decrease in precipitation largely played out in two exceptionally dry years in 2001 and 2007 (Figure 3-40).

Figure 3-1. Time series graph of annual total precipitation from 2000–2009 with longer-term annual averages from 2000–2009 and 1980–2009



ForWarn is a web-based tool that provides systematic long-term vegetation monitoring using moderate resolution satellite-based imagery (Hargrove et al. 2009). ForWarn uses the Normalized Difference Vegetation Index (NDVI) which provides a robust measure of greenness across seasons. Summed to the year, NDVI provides a measure of vegetative productivity which is often linked to stand age, health, or vigor which can vary with disturbance or climate stress. When the annual average NDVI is plotted with annual precipitation, illustrating the decline in NDVI associated with dry years and the rate of recovery following the return to average or above precipitation (Figure 3-41). While climate explains much of the variability in NDVI, other factors, including management activities, can play a role.

Figure 3-2. Time series graph of annual total precipitation and NDVI from 2000–2011 with longer-term annual averages from 2000–2011



In reviewing the literature, the following findings can be made concerning the current conditions and trends of flooding and drought in the southeastern states:

- Extreme precipitation events and intensity of precipitation will increase (Fay et al. 2008; Biasutti et al. 2011; Pitchford et al. 2011).
- The area of moderate to severe spring and summer drought has increased by 12 percent and 14 percent, respectively, since the mid-1970s. Even in the fall months when precipitation tended to increase in most of the region, the extent of drought increased by 9 percent (Karl et al. 2009).
- The NASH (North Atlantic Subtropical High) system will likely intensify, expand, and more farther westward in the 21st century with the increase of carbon dioxide, indicating increased likelihoods of both extreme rainfall events and drought over the southeastern United States in the future (Li et al. 2010).
- Temperature increases will intensify the hydrological cycle, and extremes (floods and droughts) are likely to increase in frequency and magnitude (Wu et al. 2012).

Tornadoes and Downbursts

North American cyclone numbers have increased over the last 50 years, with no statistically significant change in cyclone intensity (Seneviratne et al. 2012). However, there is a much uncertainty in the current and predicted trends of tornadoes and downbursts (as per the literature as follows):

- Current understanding of tornado and downburst formation from supercell storms is very incomplete and climate-change model predictions sufficiently coarse, that predictions of changes in frequency, size, intensity, or timing of these extreme events must be regarded as highly uncertain (Peterson 2000).

- Until knowledge of supercell thunderstorm formation is much improved, we can have only limited confidence in long-term projections about tornado and downburst climatology, although some very general suggestions warn that an increase in number and severity would be consistent with predicted continental and regional-scale changes in climate (Peterson 2000).
- An increase in atmospheric greenhouse gas concentrations may cause some of the atmospheric conditions conductive to tornadoes such as atmospheric instability to increase due to increasing temperature and humidity, while others such as vertical shear to decrease due to reduced pole-to-equator temperature gradient. But the literature on these phenomena is extremely limited with low confidence projections of changes in such small-scale systems (Seneviratne et al. 2012).

Ice Storms

In reviewing the literature there is limited knowledge concerning the current and projected trends of ice storms. A few findings are as follows:

- Ice storms increase potential fire risk by elevating fuel loads and limiting stand access (Bragg et al. 2003; Irland et al. 2000).
- Ice storms are the primary cause of tree mortality with substantial ice damage historically occurring at least once a decade along a belt from Texas to New England (Galik and Jackson 2009).
- Forests may suffer less damage during each ice storm event of similar severity in a future with higher atmospheric carbon dioxide (McCarthy et al. 2006).
- In a changing climate, the Mid-Atlantic is likely to experience less snow and ice (Galick and Jackson 2009).

Hurricanes

With Hurricane Hugo in 1989, the Francis Marion was significantly impacted. In reviewing the literature, the current and predicted trends are as follows:

- Future warming may lead to an upward trend in tropical cyclone destructive potential, and taking into account an increasing coastal population, a substantial increase in hurricane-related losses in the 21st century (Emanuel 2005).
- Numbers of strong tropical cyclones in the North Atlantic have been above normal (based on 1981 to 2000) in 9 of the last 11 years, culminating in the record breaking 2005 season. Globally, estimates of the potential destructiveness of hurricanes show a substantial upward trend since the mid-1970s, with a trend toward longer lifetimes and greater storm intensity (Nicholls and Alexander 2007).
- The intensity of Atlantic hurricanes is likely to increase during this century with higher peak wind speeds, rainfall intensity, and storm surge height and strength (Karl et al. 2009).
- The average intensity of tropical cyclones is expected to increase by 2 to 11 percent while the frequency of tropical cyclones occurrence is expected to decrease by 6 to 34 percent. The most intense storms produce by far the greatest damage (Biasutti et al. 2011).
- A recent study using an operational hurricane prediction model shows a tendency towards increased frequency of Atlantic category 4 and 5 hurricanes over the 21st century (Knuston et al. 2010).
- Tropical-cyclone-related rainfall rates are likely to increase with greenhouse warming (Knuston et al. 2010).

- Storm-surge incidence from tropical cyclones would be expected to increase (Knuston et al. 2010).
- In a study of the Hobcaw Forest in coastal South Carolina, after Hurricane Hugo, Gresham reported that longleaf pine (*Pinus palustris*) suffered less damage than loblolly pine (*Pinus taeda*) (Johnsen et al. 2009).
- The two ends of the species susceptibility to hurricane damage are loblolly pine and baldcypress (*Taxodium distichum*). When both of these southern Florida types were exposed to Hurricane Andrew in 1992, the pines experienced 25 to 40 percent damage while the bald cypress was less than 10 percent) (McNulty 2002).

Temperature Extremes

In reviewing the literature, there are numerous citations that state minimum temperatures have significantly increased over the last 50 years with a few citations expecting heat waves to become more intense in the future (a few findings are listed here).

- Since 1950 it is very likely that there had been a reduction in the frequency of extreme low temperatures, with a smaller increase in the frequency of extreme high temperatures (Nicholls and Alexander 2007).
- The number of freezing days in the Southeast has declined by 4 to 7 days per year for most of the region since the mid-1970s (Karl et al. 2009).
- Regarding projections of extreme temperatures, the AR4 [IPCC Assessment Report 4] noted that cold episodes were projected to decrease significantly in a future warmer climate and considered it very likely that heat waves would be more intense, more frequent, and last longer in a future warmer climate (Senevirante et al. 2012).
- For the SRES [Special Report on Emissions Scenarios] A2 and A1B emission scenarios a 1-in-20-year hottest day is likely to become a 1-in-2-year annual extreme by the end of the 21st century (Senevirante et al. 2012).
- In the Gulf, a typical winter in the last decades of this century will be as warm as the warmest winter ever recorded and the coolest summers will be as hot or hotter than any summer in the last century, in 95 percent of the years, summer temperatures will be unprecedented (Biasutti et al. 2011).

Sea-level Rise

In reviewing the literature it is clear that sea-level rise is currently occurring and is projected to increase through this century (Figure 3-43).

The current and predicted trends are as follows:

- The average rate of sea-level rise over the 20th century was 1.7 millimeters (0.067 inches) year from analysis of tide-gauge data. The rate has increased in recent years. From 1993 to 2003, the average rate of sea-level rise was approximately 3.1 millimeters (0.12 inches) year with approximately half that rate coming from thermal expansion. Sea level is presently rising at a rate of 3.4 to 3.5 millimeters (0.13 to 0.14 inches) per year based on satellite-based sea surface altimetry, tide gauges, and global gravity measurements (Biasutti et al. 2011).
- The mean sea level trend is 3.15 millimeters per year with a 95 percent confidence interval of ± 0.25 millimeters per year based on monthly mean sea level data from 1921 to 2006 which is equivalent to a change of 1.03 feet in 100 years (Figure 3-42) (NOAA 2013).

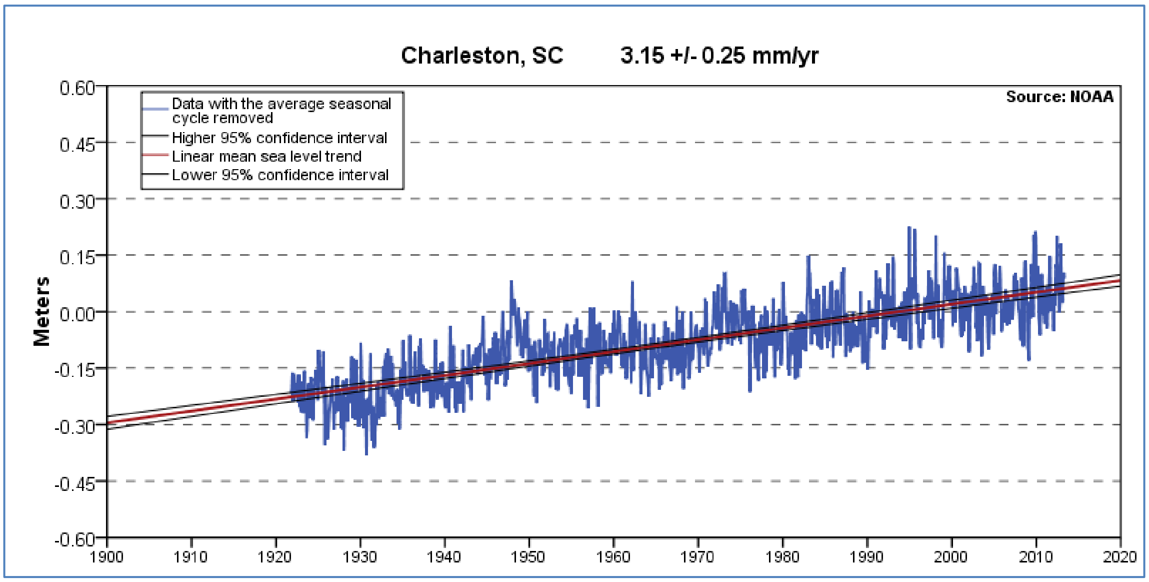
- Recent studies have shown that sea level may rise by 0.8 to 2.0 meters (31 to 78 inches) by 2100 (Pfeffer et al. 2008).
- Estimates of future global sea-level rise have recently been revised upwards. Estimates by Rahmstorf (2007) suggest global sea-level rise could increase by 4 feet (48 inches) by 2100, depending on the warming scenario employed, as opposed to a very modest 0.6 to 1.9 feet (7 to 23 inches) projected in the most recent assessment of the IPCC (Intergovernmental Panel on Climate Change) (Moser et al. 2009).
- Groundwater inundation may be an impact of sea-level rise by the latter half of the century to those areas lying between 0.66 and 1 meter (26 and 39 inches) of the mean higher high water (MHHW) (Rotzoll and Fletcher 2012).
- It is considered likely that sea-level rise has led to a change in extreme coastal high water levels (Seneviratne et al. 2012).
- It is generally understood that sea-level rise is expected to result in the inland migration of the mixing zone between fresh and saline water (Werner and Simmons 2009).
- Even with no increase in hurricane intensity, coastal inundation and shoreline retreat would increase as sea-level rise accelerates, which is one of the most certain and most costly consequences of a warming climate (Karl et al. 2009).
- Cape Romain's barrier islands will suffer from the effects of coastal erosion in addition to inundation as sea levels rise. Thus, the barrier islands may become fragmented as a result of subsidence and sea-level rise. The destruction of these barrier islands will allow increased wave energies to enter and attack the refuge's marsh (Daniels et al. 1993).
- The low sea-level rise scenario predicts a 31 centimeter rise in sea level and 22 centimeters of subsidence by the year 2100. This 53 centimeters is very close to, or exceeds, the estimated vertical accretion rate of the marsh (i.e., ~5 millimeters/year), and as a result, may inundate 51.4 percent of Cape Romain (Daniels et al. 1993).
- The higher sea level will reduce the relative height of the barrier islands, making them more vulnerable to overwash by tropical storms (Chavez-Ramirez & Wehtje 2011).
- From an ecological perspective, one of the major implications of rising seas in potential inundation of vast areas of low-lying emergent Spartina dominated marshes, which are among the most productive ecosystems on earth (Erwin et al. 2006).

Sea-level Rise Affecting Marshes Model (SLAMM). The SLAMM model summarizes landcover changes driven by sea-level rise. It was parameterized and run by the Biodiversity and Spatial Information Center (BaSIC) at North Carolina State University. SLAMM simulates geomorphological processes (i.e., accretion, erosion, and marsh migration). It was run on the Francis Marion based on analysis of results corresponding to the A2 (high emissions) sea-level rise scenario from the Intergovernmental Panel on Climate Change (IPCC 2001) (Figure 3-42).

In reviewing the results predicted landcover change between 2000 and 2050 is dominated by conversion of upland undeveloped to scrub/shrub transitional marsh. The latter half of the century (2050 to 2100) is characterized by more gradual conversion of scrub/shrub transitional marsh to other conditions, including salt marsh.

The geographic distribution of land cover classes, including a map highlighting areas predicted to experience varying degrees of change is included in Figure 3-43.

Figure 3-3. Sea-level rise from 1900 to 2012 at Charleston, South Carolina (NOAA 2013)



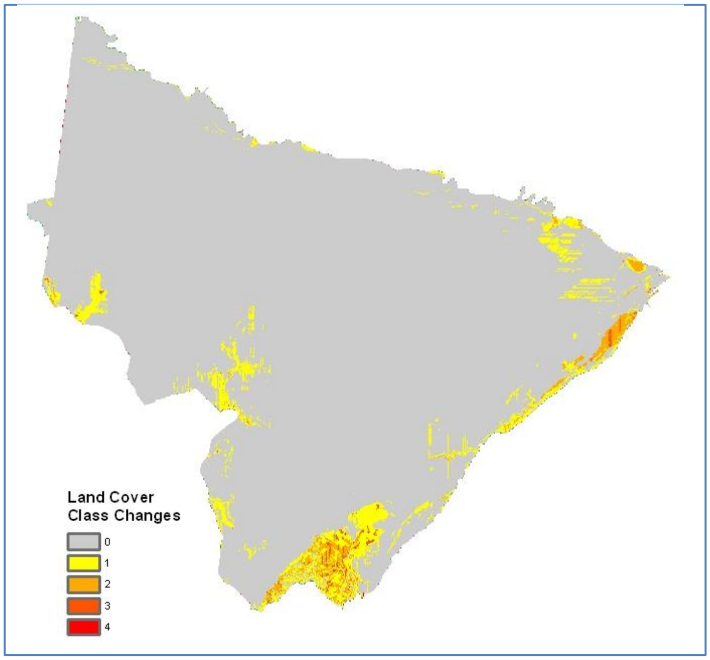


Figure 3-4. Sea-level rise; change in landcover class by 2100

3.8 Human Disturbance

3.8.1.1 Preliminary Findings

1. Projects now in planning stages are expected to complete most of first thinning harvest needed in stands that were established after Hurricane Hugo. It is anticipated in the future more regeneration harvests will occur.

2. The Francis Marion National Forest has an active prescribed burning program, with an average of 35,000 acres burned annually. Prescribed fire accomplishments since 2007 have varied from year to year with the highest acreage of 40,263 being achieved in fiscal year 2008 and the lowest acres occurring in 2012. During fiscal years 2007–2012 over 200,000 total acres of ecosystem were treated with prescribed fire.

3. Approximately 576 miles of national forest system Roads exist on the Francis Marion National Forest.

4. One of the greatest trends currently affecting the management of land ownership status and land use and access patterns is the escalating housing development on private rural lands adjacent to existing national forest. Farms, including those adjacent to Forest, are being lost to development (Forest Service 2007). Development on adjacent properties has led to an increased number of issues with trespass, illegal trails, title claims, encroachments, and law enforcement problems such as poaching, illegal posting of Forest lands, and user conflicts.

5. Hydrologic modifications (dams, dikes, ditches, bedding, etc.) are specifically designed to alter hydrology.

3.8.1.2 Introduction

Human ground-disturbing activities act as system drivers and stressors on the Francis Marion National Forest. Major disturbances including timber harvest, prescribed burning, roads, land use and hydrologic modifications will be discussed in this section.

3.8.1.3 Current Conditions and Trends

Timber Harvest

From 1996 through 2012, the Francis Marion sold commercial thinning harvests on approximately 30,000 acres of land. Commercial thinning has been the sole focus of timber harvest on the Forest since a few years after Hurricane Hugo. This emphasis is beginning to shift. Projects now in planning stages are expected to complete most of first-thinning harvest needed in stands that were established after Hurricane Hugo. It is anticipated in the future more regeneration harvests will occur.

For additional information on this topic please refer to section 8.4 "Timber."

Prescribed Burning

The Francis Marion National Forest has an active prescribed burning program, with an average of 35,000 acres burned annually. Prescribed fire accomplishments since 2007 have varied from year to year with the highest acreage of 40,263 being achieved in fiscal year 2008 and the lowest acres occurring in 2012. During fiscal years 2007–2012 over 200,000 total acres of ecosystem were treated with prescribed fire.

The percent of the longleaf pine forest types which have been prescribed burned in the last 5 years has increased from fiscal year 2008 (60 percent) to fiscal year 2012 (66 percent).

The desired condition for the Forest is to maintain fire-adapted ecosystems using a fire-return interval of once every 3 years (Forest Plan 1996). The total area that would benefit from fire is approximately 160,000 acres. The current levels of treating 30,000 to 40,000 acres per year falls short of the 53,000 acres needed. Fire is critical to restoring and maintaining red-cockaded woodpecker habitat and fire-dependent communities. The Francis Marion is using different strategies to increase the number of acres burned annually.

Please refer to section 3.4 "Wildland Fire/Fuels", section 4 "Carbon Assessment", and section 2.2 "Air Quality" for more information on the effects of prescribed burning.

Roads

There are approximately 576 miles of national forest system roads on the Francis Marion National Forest. Efforts to maintain these roads are in accord with established road management objectives and are described by maintenance levels 1–5. Maintenance level 1 is custodial maintenance and corresponds to roadways not generally maintained for vehicle travel; maintenance level 2 is maintained for passage by high clearance vehicles; maintenance levels 3–5 are maintained for passenger vehicles at increasing levels of comfort and speed. Maintenance level 5 roads are typically paved.

Please refer to section 11.4 "Roads" for more information.

Land Uses

The Francis Marion National Forest is comprised of approximately 259,537 acres (based on 2012 GIS, basic surface area layer).

The Forest is experiencing the effects of urbanization at a higher level than other forests in the Southern Region. Acquisition funds have been very limited while timber companies have been divesting themselves of large acreages near the Forest. Land acquisition has become increasingly difficult and private landowners are less willing to allow public access across their lands (2008 Forest Plan Review).

One of the greatest trends currently affecting the management of land ownership status and land use and access patterns is the escalating housing development on private rural lands adjacent to existing national forest. These also include farms adjacent to Forest system lands (Forest Service 2007). Development on adjacent properties has led to an increased number of issues with trespass, illegal trails, title claims, encroachments and law enforcement problems such as poaching, illegal posting of Forest lands, and user conflicts.

Please refer to section 14.1.2 "Land Status and Ownership" and 14.1.3 "Land Use" for more information.

Hydrologic Modifications

Hydrologic modifications (dams, dikes, ditches, bedding, etc.) are specifically designed to alter hydrology, either by (1) draining wetlands and wet areas to make the areas accessible; (2) draining riparian areas for some of the same purposes; (3) retaining water for rice or indigo culture; (4) retaining water for other uses such as hydroelectric generation, recreation, irrigation, flow transfer, etc.; (5) channelizing or straightening streams to reduce flooding, and (6) bedding, draining, or modifying sites to convert bottomland hardwoods to pine. *Please refer to section "1.3 Watersheds" for more information.*

3.8.1.4 Information Needs

Information needs include the distribution and trends of nonnative invasive plants and the adequacy of prevention and control methods.